Lighting now accounts for an estimated 19 percent of global energy consumption. Projections show that demand for artificial light will grow 80 percent by 2030. Global awareness has heightened government and corporate initiatives to reduce carbon emissions, concurrently elevating demand for sustainable lighting sources. As traditional incandescents are phased out over the next five years due to tighter energy regulations in all major western countries, new government standards worldwide will drive market adoption of more efficient lighting choices. New Solid-State Lighting (SSL) technology has gained impressive traction and could potentially fill the gap, while reducing lighting energy consumption 50 percent by 2025.

Sustainable solid state lighting technology gains traction

LEDs are at the forefront, driving a paradigm shift away from traditional incandescent and fluorescent lights and toward more energy efficient, longer-life, sustainable solutions. From street lights to giant video screens, from car headlights to indoor illumination, SSL systems offer compelling benefits and are already making strides toward transforming the industry. Today’s advanced LED lighting technologies can deliver the sustainability, scalability, and design flexibility that OEMs need to engineer competitive solutions for the SSL residential, commercial and industrial markets.

The energy efficiency of LED technology aligns with the widespread proliferation of corporate sustainability programs. By using LED modules rather than conventional lamps, it is now possible to reduce power consumption by as much as 90 percent. And, while the initial investment may be higher, return on investment can be realized in one year if replacement costs are included. Beyond energy savings, the use of LED lighting products delivers measurable maintenance cost reductions. Conservatively, LEDs last more than 25 times—ranging up to 40 times—longer than incandescents and five times longer than CFLs (compact fluorescent lamps).

LEDs are also more physically robust than the average incandescent or CFL light source. With no filament to break, LEDs can withstand heavy vibration, shock and impact better than traditional lamps. Aesthetically, LEDs are dimmable and have the advantage of instant-on capability, with good color rendering and a full color spectrum. They operate silently on a low voltage current, without mercury or lead, and are completely safe for UV sensitive applications. The development of white light LEDs offers a more appealing presentation for an even wider array of applications as LED technology moves beyond the early adoption stage.

Convergence of LED lighting and electronics

Despite these clear advantages, there are challenges intrinsic to LED technologies. For example, while LEDs run significantly cooler than incandescent lamps, without proper thermal management their effective service life can be shortened considerably due to heat build-up within the LED junction. Incandescent and fluorescent lighting sources conduct heat through the glass bulb surface. LEDs require a method for disbursing heat by conduction through the back of the LED. With a heat sink and proper thermal management, LED fixtures can last an impressive 50,000 hours at 70 percent lumen maintenance under normal usage.

LED emitters have typically been soldered to PCBs and assembled to integrated fixtures, without a mechanism to replace a failed LED or update the LED. This assembly approach poses several challenges to the fixture manufacturer, being closer to an electronics assembly than a typical lighting fixture. Even well-established fixture manufacturers can struggle with light sources that are actually electronic components requiring a secure connection to an electronic circuit. Successfully soldered designs still leave solder joints vulnerable to stress during handling. A cold solder joint can result in scrapping a high cost LED array.
The LED lighting industry effectively converged into the electronic component space, requiring different expertise that did not yet exist. As a result, LED product development was initially slow, because the industry was rightly cautious about investing heavily in fixtures that cannot be easily assembled, repaired or upgraded. Fixture manufacturers and lighting OEMs accustomed to traditional lighting have consistently demanded LED modules that more closely emulate traditional lighting.

By combining best-in-class electrical, thermal and optical expertise with in-house design and manufacturing capabilities, Molex stepped up to address these practical design issues and needs. The resulting range of LED light modules provides unprecedented design flexibility and freedom for OEMs to differentiate their product offerings. The modular LED lighting solutions are a familiar model long used by distributors, who are now able to broaden their portfolios beyond traditional light sources to include LED sources. Advances in electronic technologies are for the first time making LED luminaires practical and affordable for mass-production.

**Modular LED assemblies blend benefits of SSL and interconnect technologies**

Released in March 2010, the Helieon LED light module combines SSL technology from Bridgelux with interconnect technology from Molex. An easy-to-use two-piece design, the Helieon light socket or lamp holder is permanently fastened into the luminaire. The light module is inserted into the socket with a push to make the electrical connections and an intuitive quarter turn to lock the module in place. By emulating a traditional lighting socket, the Helieon system delivers an easy and familiar installation experience. Helieon was designed for lighting OEMs intent on driving mass-market adoption of LED lighting.

Helieon modules for high-volume applications are available in two basic outputs, 800 or 1200 lumens (which are roughly comparable to 60W and 90W incandescent bulbs), but can be driven to provide between 500 and 1500 lumens so as to meet a wide range of lumen output requirements. Helieon modules also provide a compact design as the module is just 80 mm (3.15") in diameter and when mated to the socket, the assembly is just 27.6 mm thick.

Helieon delivers to interior and exterior luminaire manufacturers effortless installation, interchangeability, and upgradeability. The simple plug-and-play modular solution allows manufacturers to adopt SSL into their luminaires, with a flexible path forward at a low price point. Luminaire designers can use Helieon to develop products in which the LED source can be easily replaced and upgraded, and do so at price points that offer short payback periods for SSL installations.

The socketed, interconnect Helieon interface enables lighting fixture manufacturers globally to develop products based on the technology, allowing for faster industry adoption. Limited only by one’s imagination, Helieon applications might include—down lights, task or accent lights, spot and track lights, troffers and interior-area lighting, retail and display lighting, hospitality lighting, architectural lighting, decorative lighting, and even museum lighting. Supporting industry standardization of the module interconnect technology will help to ensure long-term design opportunities, while protecting the development investment of fixture OEMs and their customers.

**Printed circuit assemblies for seamless LED subassemblies**

LED printed circuit assemblies offer a dependable and efficient custom lighting solution that works seamlessly with the Helieon product line for LED subassemblies across numerous industries. Connector and LED design integration equates with a complete solution, leveraging proven products and technologies to support total LED interconnect needs. In-house functional testing of all printed circuit assemblies ensures quality and consistency of intensity and color.

Circuit board reliability and design blends electrical, mechanical, thermal, and optical function into a fully qualified LED package. Custom LED assemblies support backlighting applications with polyester circuits that support lower power consumption applications and heat-sinked polyimide and rigid boards to support high power consumption applications, such as surgical and automotive lighting. A BIN control system regulates consistent lot-by-lot LED luminosity output ranges, which are critical in a quality lighting product.

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Array holders for modular LED assemblies eliminate hand soldering and ease LED installation

In 2010, in addition to the Helieon partnership, Molex also launched a solderless LED array holder designed initially for Bridgelux ES and RS arrays. A perfect complement, the LED array holder delivers the same high performance and plug-and-play design in a cost-effective SSL solution. An innovative interconnect system, the LED array holder simplifies the installation of LED assemblies, and facilitates upgrades when more efficient or brighter lights become available. Solderless LED array holders dramatically increase connectivity options for superior design flexibility allowing OEMs to focus on fixture design with fewer constraints and less concern about implementation.

The double-ended wire-trap terminal simplifies assembly, allowing flexibility in wire orientation to achieve optimal wire routing. Using a simple tool the releasable dual wire trap enables field replacements and facilitates upgrades to current applications. The one-step solderless screw down connection system eliminates the need for wire soldering. Surface Mount Technology (SMT) soldering or other secondary processing during assembly, for substantial manufacturing savings and efficiencies. The LED array holder entirely eliminates the need for hand soldering or SMT soldering and expensive SMT equipment.

In the new array holder, secure compression power contacts provide a stable connection even in high-ambient temperature and prevent potential failures due to cold or unreliable solder joints. Other standard features include built-in mounting points for secondary optics. An optional clear LED protective cover, with a snap-lock, protects the LED from dust and assembly process handling.

Because there is no secondary processing required, Molex array holders help facilitate quick design cycles and ease system-level integration challenges for OEMs. Designs have primarily focused on sizing for 48-50mm diameter light sources. Form factors smaller than 50.00mm (1.96") in diameter make the LED array holder ideal for lamps and other small-fixture applications, including MR16 or track lighting using thermoplastic housing to support high heat-generating environments. A range of smaller form factors allow light fixture OEMs to maintain standard lighting designs in place without costly redesign.

Array holders are a very simple and low-tech form of a connector. It’s fundamentally a retention system to electrically connect an LED fixture to a set of wires. The secondary function of an array holder is to facilitate a thermal interface between the LED and heat sink. By clamping and applying pressure to thermal interface materials, typically a pad, grease, or phase change material, the array facilitates that thermal connection. Molex array holders must meet UL testing 496 for lamp holders. Improving creepage and clearance between the LED and the heat sink or any other metal conductive surface reduces energy usage and the cost for more frequent LED replacement, and also enables use of lower cost Class 1 power supplies.

Use of an array holder basically augments the traditional method of screwing down the LED directly to the heat sink. Attachment points on the array are an important feature, allowing integration of the thermal barrier, optics, and, in some cases, clear covers to provide ingress protection. In addition to lighting optics, the ease of assembly allows for secondary optics.

Molded interconnect device (MID) technology enhances LED design options

Depending on the LED form factor, a number of technologies are available to power an array. The Helieon assembly, for example, uses a standard stamp and form contact solution. A more recent development, array holder embellishments can incorporate an internally molded interconnect device (MID) used to apply circuitry onto 3D plastic parts, which allows for more integrated technologies and unique packaging concepts. MID enables use of complex electronics in a very compact SSL light source. This new technology embeds circuitry patterns onto specialty metalized plastic with a laser activated surface. After laser etching activation, the surface is plated (copper-nickel/tin-gold), providing a 3-dimensional
electromechanical package onto which components, connectors, and LEDs can be added.

An MID package solves process challenges OEMs encounter connecting LEDs and soldering wires in a space made even tighter by wire gauge and contact screws. As an alternative to using multiple (six pads in the case of the Cree MPL LED) top contact pads on an LED assembly, MID enables using two contacts, anode/cathode I/O which can then be jumpered from six independent LED power connections. This eliminates the need to alternate pos-neg in a row and allows for power deployment in either a serial or parallel architecture.

A well-established technology, MID has been entrenched in medical and mobile markets, and used extensively in the development of antennas for smart phones. It stands to significantly advance the mass market production of next generation SSL products. Concurrently, industry can expect a proliferation of MID-enabled LED lighting control systems with network devices, allowing end users greater flexibility and control over their lighting experience and environment. Intelligent lighting controls are already making jobs easier and industries more sustainable. Modern commercial, industrial and residential buildings are incorporating local area networks directly into lighting systems to monitor maintenance requirements, determine occupancy, and offer daylight controls and light dimming systems—yet a few more simple and transformative methods for lighting OEMs to harness electronic technology.

As LED adoption progresses globally the integration of modular assemblies, array holders, MID and other electronic technologies are sure to play an increasingly integral role in lighting the way toward OEM development of sustainable and competitively-priced SSL products far into the future.